

[0027] FIG. 2 is an elevational view of the apparatus of FIG. 1;

[0028] FIG. 3 depicts color response of a sensor array;

[0029] FIG. 4 is a graph depicting one example of a transmission spectrum for an ultraviolet (UV) filter;

[0030] FIG. 5 depicts one embodiment of spectral response for a sensor array where UV and infrared (IR) filters are used;

[0031] FIG. 6 depicts spectra for two illumination sources;

[0032] FIG. 7 is an illustration of the HUNTER LAB™ color space;

[0033] FIG. 8 is a simplified block diagram of the hand-held, portable device having a wireless link to a remote data processor, such as one that may be used to track color measurements;

[0034] FIG. 9 is an example of a Bayer mosaic pattern of color filters for overlying the sensor, and

[0035] FIG. 9A is an illustration of the effect of combining a group of sixteen pixels to effectively yield an composite color pixel;

[0036] FIG. 10 is an illustration of an image of a document submitted for authentication, and FIG. 10A is an exploded view of a portion of the image wherein security features are shown;

[0037] FIG. 11 is an illustration of a color cone;

[0038] FIG. 12 is an illustration of two valid color areas;

[0039] FIG. 13 is a flow chart depicting aspects of the process for authentication;

[0040] FIG. 14 is a graph depicting a comparison of device performance for various color security features;

[0041] FIG. 15 is an illustration of a document standard;

[0042] FIG. 16 depicts a histogram of various hand sheets containing green security particles;

[0043] FIG. 17 depicts a linear fit of green average counts and loading densities;

[0044] FIG. 18 depicts a histogram of various hand sheets containing blue security particles;

[0045] FIG. 19 depicts a linear fit of blue average counts and loading densities;

[0046] FIG. 20 depicts a histogram of various hand sheets containing yellow security particles;

[0047] FIG. 21 depicts a linear fit of yellow average counts and loading densities;

[0048] FIG. 22 depicts a histogram of various hand sheets containing red security particles;

[0049] FIG. 23 depicts a linear fit of red average counts and loading densities;

[0050] FIG. 24 is a graph depicting counts versus distance with best focus at each distance;

[0051] FIG. 25 is a graph depicting counts versus distance with a fixed-focus distance of 8 cm;

[0052] FIG. 26 depicts readout of GBY security particles without any overprint;

[0053] FIG. 27 depicts readout of GBY security particles with 30% overprint of cyan ink;

[0054] FIG. 28 depicts readout of GBY security particles with a 30% overprint of magenta ink;

[0055] FIG. 29 depicts green and blue particles and the respective valid color areas in the GB plane with a 30% yellow overprint;

[0056] FIG. 30 is a graph depicting a series of 100 successive images collected with the device wherein the placement of the subject was held constant;

[0057] FIG. 31 is a histogram presentation of the data in FIG. 30;

[0058] FIG. 32 is a graph depicting a series of 100 successive images collected with the device wherein the placement of the subject was not held constant;

[0059] FIG. 33 is a histogram presentation of the data in FIG. 32;

[0060] FIG. 34 depicts performance of various flash illumination units; and,

[0061] FIG. 35 depicts a normalized spectral response for PolyStar™ security particles.

DETAILED DESCRIPTION OF THE INVENTION

[0062] These teachings are directed to a system for assuring security of documents and other similar substrate. Disclosed herein are the use of security features which provide document security, and a system for recognition of the security features and the subsequent authentication of the document. One skilled in the art will recognize that the teachings herein may be useful in authentication schemes for a variety of instruments including personal identification, currency, notes, original works, and others. Although discussed herein in terms of a “document”, this is a non-limiting embodiment of a substrate, and considered only to be illustrative of the invention disclosed herein.

[0063] The document security system includes, but is not limited to, use of security particles, which include certain pigments, as one embodiment of a security feature. The security particles may have enhanced security value, as described herein. The security particles can be incorporated into documents through various techniques. An appropriately designed and configured detection system provides for recognition of the security particles, or other security features, and may perform logical decision making processes in order to provide authentication information.

[0064] Security Particles

[0065] As disclosed herein, security particles provide for the authentication and therefore security of a document. However, many other types of security features may be used, alone, or in combination with the security particles. Some of these other security features include, without limitation: threads, ribbons, discs, planchets, fluorescent printing and fibers. The security particles disclosed herein are therefore but one embodiment of a security feature for a document. Although the disclosure herein generally refers to the use of